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Description

ELECTRIC POWER STEERING SYSTEM

5 <Technical Field>

The present invention relates to an electric power steering system which is designed to increase convenience in mounting a steering column by making the oscillation of the steering column moderate.

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<Background Art>

In recent years, power steering systems are incorporated in steering systems of vehicles in order to alleviate the steering effort made by the driver when he or she steers the vehicle. A main stream of those power steering systems currently used is an electric power steering system in which a steering assist force is imparted by an electric motor which receives power supply from a battery. In the electric power steering system, a column assist method is used preferably in which an electric assist unit is incorporated in the steering column, whereby driving power of an electric motor is transmitted to an output shaft at a speed which is reduced appropriately so as to provide a necessary assist force for steering.

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While the use of the electric power steering brings many advantages in steering the vehicle, the electric power steering system of the column assist type never fails to increase the weight due to the electric assist unit, and for example, when mounting such a steering column on a vehicle, a worker is forced to undertake difficult work due to the oscillation of the steering column without moderation when compared to a steering column having an electric assist unit installed thereon.

An example of the column assist type electric power steering system is shown in Fig. 11. This steering system is configured such that a steering column is made to oscillate vertically by means of a tilt pivot of a tilt mechanism. The steering column 51 has a steering upper shaft 52 which is rotatably provided in an interior of the steering column 51. The steering column 51 includes at a lower portion thereof an electric assist unit 56 which is made up of an electric motor 53, a gear housing 54 and an output shaft 55. For example, when the driver turns a steering wheel, not shown, a steering effort imparted thereby is transmitted from the steering upper shaft 52 to the electric assist unit 56, and the steering effort is then enhanced by an assist force by the electric motor 53, the enhanced effort being transmitted to the output shaft 55.

On the other hand, the tilt mechanism which includes a tilt clamp 57 and a tilt pivot 58 is provided on the steering column 51 in order to allow the driver to take a desirable driving position for him or her. As shown in Fig. 12, the tilt clamp 57 is configured such that a distance bracket 59 fixed to the steering column 51 is held by an upper bracket 60 which is mounted on a vehicle body and a rod member 61 which is passed through both the brackets 59, 60 is tightened by means of a lever 62 and a nut 63 which is taper fitted in the lever 62. Normally, vertical elongate holes 64 are formed in the upper bracket 60 which match in length a tilt stroke of the steering column 51. The smooth oscillation of the steering column 51 is enabled by a vertical movement of the rod member within the elongate holes 64.

In addition, as shown in Fig. 13, the tilt pivot 58 is configured such that a yoke member 67 extending from the gear housing 54 is brought into engagement with two pin members 66 which are mounted on a lower bracket 65 which is mounted on the vehicle body. By using the device like this, when performing a tilt operation, the steering column 51 can be made to oscillate about the pin members 66 as a center of oscillation.

There is proposed an electric power steering system in which in order to make the oscillation of a steering

column 51 moderate, in particular, in order to restrict the spring up of the steering column 51 due to an upward bending moment when the steering column 51 is dislodged from a vehicle body mounting portion due to a high load being applied from a steering wheel side, a plate member is installed at a position near an upper limit of a tilt stroke in such a manner as to oppositely face an upper surface of the steering column 51 so as to prevent an excessive rotation of the steering column (refer to, for example, JP-A-2000-127991 (page 4, Fig. 2)).

#### <Disclosure of the Invention>

With the column assist type electric power steering system, in installing the steering column on the vehicle, due to the electric assist unit 56 having a large mass, as shown in Fig 14, the steering column 51 tends to easily rotate about the pin members 66, and some means has to be used to prevent the rotation. For example, as shown in Fig. 13, it is a currently adopted practice that a rotation preventing screw 68 is temporarily mounted on the steering column 51 in such a manner as to penetrate the lower bracket 65, so as to prevent the rotation of the steering column 51 during assembly, and the screw 68 is removed from the steering column 51 when the installation has been completed. However, the method using the rotation preventing means lacks convenience

due to a certain length of time being necessary to mount and remove the screw 68.

On the other hand, with an energy absorbing steering column, when a high load is exerted thereon from a steering wheel side, since an upper bracket 60 is dislodged from a vehicle body, a steering column 51 is restrained by a tilt pivot 58 only. In this event, as shown in Fig. 15, the steering column 51 is sprung upwards due to an upward bending moment, and for example, there may be caused a possibility that it will be difficult to maintain an optimum inflation and deployment of an airbag.

An object of the invention is to provide an electric power steering system which enhances convenience in mounting a steering column on a vehicle body by making the oscillation of the steering column moderate and restricts a free movement of the steering column in the event that the steering column is dislodged.

The invention provides an electric power steering system including an upper bracket fixed to a vehicle body, a steering column disposed between a pair of tightening plate portions of the upper bracket, a steering shaft provided rotatably within the steering column, a tilt mechanism including a tilt clamp which tightly fastens the steering column between the tightening plate portions

of the upper bracket and a tilt pivot which oscillates the steering column, an electric assist unit lying at a lower end of the steering column to transmit an assist force of an electric motor to an output shaft and a lower  
5 bracket fixed to the vehicle body at an opposite side of the electric assist unit to the steering column to rotatably support a pivot shaft of the tilt pivot, wherein a housing of the electric assist unit is brought into engagement with the pivot shaft of the tilt pivot via  
10 a connecting member in such a manner as to be allowed to move loosely, so that the steering column is allowed to oscillate about the pivot shaft, and wherein a column rotation restricting portion is provided between the lower bracket and the housing.

15 In addition, the invention provides an electric power steering system including an upper bracket fixed to a vehicle body, a steering column disposed between a pair of tightening plate portions of the upper bracket, a steering shaft provided rotatably within the steering  
20 column, a tilt mechanism including a tilt clamp which tightly fastens the steering column between the tightening plate portions of the upper bracket and a tilt pivot which oscillates the steering column, an electric assist unit lying at a lower end of the steering column  
25 to transmit an assist force of an electric motor to an

output shaft and a lower bracket fixed to the vehicle body at an opposite side of the electric assist unit to the steering column to rotatably support a pivot shaft of the tilt pivot, wherein a housing of the electric assist unit is brought into engagement with the pivot shaft of the tilt pivot in such a manner as to be allowed to move loosely, so that the steering column is allowed to oscillate about the pivot shaft, and wherein a column rotation restricting portion is provided between the lower bracket and the housing.

Furthermore, the invention provides an electric power steering system including an upper bracket fixed to a vehicle body, a steering column disposed between a pair of tightening plate portions of the upper bracket, a steering shaft provided rotatably within the steering column, a tilt mechanism including a tilt clamp which tightly fastens the steering column between the tightening plate portions and a tilt pivot which oscillates the steering column, an electric assist unit lying at a lower end of the steering column to transmit an assist force of an electric motor to an output shaft, a bracket fixed to a housing at a steering column side of the electric assist unit so as to rotatably support a pivot shaft of the tilt pivot, and a lower bracket fixed to the vehicle body at an opposite side of the electric

assist unit to the steering column, wherein the steering column is brought into engagement with the pivot shaft of the tilt pivot via a connecting member in such a manner as to be allowed to move loosely, so that the steering column is allowed to oscillate about the pivot shaft, and wherein a column rotation restricting portion is provided between the bracket and an inner column of the steering column.

In the invention, to restrict the oscillation of the steering column, a reference angle is determined which is slightly larger than an angle which satisfies a tilt stroke. The column rotation restricting portion such as a stopper projection which resists the rotation is disposed in order to forcibly stop the oscillation of the steering column when the rotating angle of the tilt pivot reaches an angle corresponding to the reference angle. In the event that the column rotation restricting portion is disposed, since the tilt pivot does not reach a rotating angle which corresponds to the reference angle in a tilt adjustment operation, the oscillation of the steering column is not interrupted at all, whereby the steering column can be inclined smoothly to a desired angle. On the contrary, when the tilt pivot reaches the rotating angle, since the stopper projection comes into contact with a mating surface, the



steering column cannot rotate any further, and hence the oscillation is stopped, whereby the oscillation of the steering column can be made so moderate that the oscillation of the steering column is suppressed effectively.

Consequently, in the installation of the steering column on to a vehicle, the downward rotation of the steering column can be stopped without using the rotation preventing means such as the screw which is temporarily assembled or a stopper, whereby convenience is enhanced, thereby making it possible to enhance remarkably the assembling efficiency. In addition, also in the event that the steering column is dislodged from the vehicle body mounting portion when a high load is applied thereto, the spring up or falling of the steering column can be prevented, thereby contributing to an appropriate operation of an occupant protection system or the like.

#### <Brief Description of the Drawings>

Fig. 1 is a side view which shows an embodiment of an electric power steering system according to the invention;

Fig. 2 is a sectional view showing a tilt clamp of the invention, which is taken along the line A-A in Fig. 1;

Figs. 3(a), (b) are diagrams which show in detail

a column rotation restricting portion shown in Fig. 1, in which Fig. 3(a) is a side view of the column rotation restricting portion, and Fig. 3(b) is a partially omitted sectional view taken along the line B-B in Fig. 3(a);

5        Fig. 4 is an operation explanatory diagram which shows how a steering column attempting to rotate downwards is stopped by the column rotation restricting portion according to the invention when the steering column is installed on a vehicle;

10       Fig. 5 is an operation explanatory diagram which shows how the steering column attempting to spring upwards is stopped by the column rotation restricting portion according to the invention;

15       Fig. 6 is an operation explanatory diagram which shows how the steering column attempting to fall downwards is stopped by the column rotation restricting portion according to the invention;

20       Fig. 7 is a side view which shows another embodiment of an electric power steering system according to the invention;

25       Figs. 8(a), (b) are diagrams which show in detail a column rotation restricting portion shown in Fig. 7, in which Fig. 8(a) is a side view of the column rotation restricting portion, and Fig. 8(b) is a view resulting when seen from a direction indicated by an arrow X in

Fig. 8(a);

Fig. 9 is a side view which shows a further embodiment of an electric power steering system according to the invention;

5 Figs. 10(a), (b) are diagrams which show in detail a column rotation restricting portion shown in Fig. 9, in which Fig. 10(a) is a view resulting when seen in a direction indicated by an arrow Y in Fig. 9, and Fig. 10(b) is a view resulting when seen in a direction  
10 indicated by an arrow Z in Fig. 9;

Fig. 11 is a side view which shows an example of a conventional electric power steering system;

Fig. 12 is a sectional view showing a conventional tilt clamp, which is taken along the line C-C in Fig.  
15 11;

Fig. 13 is a view showing a conventional tilt pivot, which is seen in a direction indicated by an arrow W in Fig. 11;

Fig. 14 is an operation explanatory diagram which  
20 shows how a steering column attempting to rotate downwards is stopped when a lower bracket is fixed to a vehicle body by a conventional technique in installing the steering column on a vehicle;

Fig. 15 is an operation explanatory diagram which  
25 shows how the steering column springs upwards in the

conventional technique when the steering column is dislodged from the vehicle body;

Fig. 16 is a side view which shows an embodiment of an electric power steering system according to the invention; and

Fig. 17 is a side view which shows another embodiment of an electric power steering according to the invention.

<Best Mode for Carrying out the Invention>

10 An embodiment of the invention will be described with reference to the drawings. In Fig. 1, an electric power steering system according to the invention has a steering column 1 and a steering upper shaft 2 which is provided rotatably in an interior of the steering column

15 1. Although omitting an illustration thereof, as part of the energy absorbing steering column, the steering upper shaft 2 is divided into an outer shaft and an inner shaft, and both the shafts are slidably connected to each other by way of such a means as serrations. In addition,

20 the steering column 1 is divided into an outer column 3 and an inner column 4, and both the columns are slidably connected to each other.

The electric power steering system includes an electric assist unit 5 which is provided continuously

25 to the inner column 4 of the steering column 1. This

electric assist unit 5 has a worm wheel which rotates together with an output shaft 7 which is disposed within a gear housing 6, and this worm wheel is brought into mesh engagement with a worm which is connected to a spindle of an electric motor 8. Due to this, the worm wheel rotates in conjunction with the rotation of the worm at a speed which is appropriately reduced, whereby an assist force by the electric motor 8 is designed to be transmitted to the output shaft 7. Note that a steering wheel, not shown, is mounted on the steering upper shaft 2. In addition, the output shaft 7 is connected to a steering system via an intermediate shaft, not shown.

In addition, the electric power steering system includes a tilt mechanism which includes a tilt clamp 9 which tightly fastens the steering column 1 to an upper bracket and a tilt pivot 10 which oscillates the steering column.

As shown in Fig. 2, in the tilt clamp 9, a pair of vertical plate portions 14a, 14b of a distance bracket 13 which is connected to the outer column 3 of the steering column 1 are held by a pair of tightening plate portion 12a, 12b of an upper bracket 11, and a rod member 15 which is provided in such a manner as to be passed through the tightening plate portions 12a, 12b and the vertical plate

portions 14a, 14b is tightened up by a lever 16 and a nut 17 which is taper fitted in the lever 16 so that the vertical plate portions 14a, 14b are fixed between the tightening plate portions 12a, 12b.

5           Vertical elongate holes 18, through which the rod member 15 is passed, are formed, respectively, in the tightening plate portions 12a, 12b of the upper bracket 11. Assuming that the steering column 1 can oscillate about the tilt pivot from a neutral position vertically  
10 through an angle  $\theta_1$  and an angle  $\theta_2$ , respectively, during a tilt adjustment operation (refer to Fig. 1), the vertical elongate holes 18 each have a length that does not interrupt the movement of the rod member 15 when the rod member moves therein.

15           On the other hand, the tilt pivot 10 is configured such that a yoke which extends from the gear housing 6 is brought into engagement with two pin members 20 which are mounted on a lower bracket 19 (refer to Fig. 3(a)) having an inverted U shape cross section which is mounted  
20 on the vehicle body. By this configuration, when the tilt clamp 9 is in an unclamped state, the steering column 1 can be oscillated about the pin members.

          In addition, in the embodiment, a column rotation restricting portion 22, adapted to restrict the rotation  
25 of the steering column 1, is provided between the lower

bracket 19 and the gear housing 6.

This column rotation restricting portion 22 is, as shown in Figs. 3(a), (b), made up of a pair of primary stopper projections 23a, 23b which is formed below the pin members 20 of the tilt pivot 10 on the lower bracket 19 in such a manner as to oppositely face the yoke member 21 and a secondary stopper projection 24 which is formed above the pin members 20 of the tilt pivot 10 in such a manner as to oppositely face the yoke member 21. The primary stopper projections 23a, 23b projects obliquely downwardly from a lower end of the bracket and distal ends of the projections confront a front surface  $f$  of the yoke member 21 with a certain gap provided therebetween. The secondary stopper projection 24 projects perpendicularly from an upper end of the bracket, and a distal end of the projection confronts the front surface  $f$  of the yoke member 21.

While a rotating angle of the tilt pivot 10 is such as not only to satisfy a tilt stroke but also to allow for the rotation to a rotating angle equal to or larger than the tilt stroke satisfying angle, an upper limit and a lower limit are determined for this rotating angle. When the steering column 1 can oscillate from a neutral position downwardly to an angle  $\theta_1$  and upwardly to an angle  $\theta_2$  (refer to Fig. 1), the lower limit and the upper

limit of the rotating angle are determined based on angles  $\theta_3$ ,  $\theta_4$  as reference which result when certain extra angles are added to the angles  $\theta_1$ ,  $\theta_2$ , respectively. Consequently, the gap is maintained between the distal ends of the primary stopper projections 23a, 23b and the front surface *f* of the yoke member 21 while the tilt pivot 10 oscillates downwardly until a rotating angle corresponding to the reference angle  $\theta_3$  is reached. On the other hand, the gap between the distal end of the secondary stopper projection 24 and the front surface *f* of the yoke member 21 is maintained while the tilt pivot 10 oscillates upwardly until a rotating angle corresponding to the reference angle  $\theta_4$  is reached.

When the tilt pivot 10 reaches rotating angles equal to or larger than the angles corresponding to the reference angles, the gaps between the two members are gone, and as this occurs, the steering column 1 oscillating downwards is restrained by virtue of the contact of the primary stopper projections 23a, 23b with the yoke member 21. On the contrary, the steering column 1 oscillating upwards is restrained by virtue of the contact of the secondary stopper projection 24 with the yoke member 24.

In the electric power steering system like this, when a tilt adjustment operation is carried out, the



steering column 1 can be inclined smoothly from the neutral position to the predetermined angles ( $\theta_1$ ,  $\theta_2$ ) by holding the gaps between the primary stopper projections 23a, 23b and the front surface  $f$  of the yoke member 21 and the gap between the secondary stopper projection 24 and the front surface  $f$  of the yoke member 21.

On the other hand, when the steering column is installed on a vehicle, the steering column 1 attempts to rotate downward about the pin members 20. When the rotating angle increases, the yoke member 21 is, as shown in Fig. 4, brought into contact with the primary stopper projections 23a, 23b, and the steering column 1 cannot rotate further, whereby the downward oscillation is stopped.

Thus, the oscillation of the steering column 1 can be made so moderate that the oscillation of the steering column is suppressed effectively, whereby, for example, the steering column can be mounted conveniently on a vehicle body without a means such as a stopper which resists the rotation of the steering column 1.

On the other hand, when the steering column 1 is dislodged from the vehicle body mounting portion due to a high load being applied thereto from a steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to spring upwards due

to a upward bending moment. When the rotating angle increases, the yoke member 21 is brought into contact with the secondary stopper projection 24, as shown in Fig. 5, and the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from springing upwards.

Thus, by making the upward oscillation of the steering column 1 moderate, a free upward movement thereof can be restricted. Consequently, the spring up of the steering column 1 can be prevented by the extremely simple device, i.e., the secondary stopper projection 24, which is added to the existing element, without using a mechanism for preventing the steering column from springing upwards.

In addition, when the steering column 1 is dislodged from the vehicle body mounting portion due to a high load being applied thereto from the steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to fall downwards. When the rotating angle increases, the yoke member 21 is brought into contact with the primary stopper projections 23a, 23b, as shown in Fig. 6, and the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from falling downwards.

Thus, by making the downward oscillation of the

steering column 1 moderate, a free downward movement thereof can be restricted. Consequently, the falling down of the steering column 1 can be prevented by the extremely simple devices, i.e., the primary stopper projections 23a, 23b, which are added to the existing  
5 element, without using a mechanism for preventing the steering column 1 from falling downwards.

With the embodiment, in the installation of the steering column 1 on to the vehicle, the downward rotation  
10 of the steering column can be stopped without using the rotation preventing means such as the screw which is temporarily assembled or a stopper, whereby convenience is enhanced, thereby making it possible to enhance remarkably the assembling efficiency.

15 In addition, also in the event that the steering column is dislodged from the vehicle body mounting portion when a high load is applied thereto, the spring up or falling of the steering column 1 can be prevented, thereby contributing to an appropriate operation of an  
20 occupant protection system or the like.

In addition, in this embodiment, as shown in Fig. 16, a primary stopper projection 23' and a secondary stopper projection 24' may be provided on a surface of the gear housing 6 which oppositely faces the lower  
25 bracket 19 in such a manner as to be spaced apart from

each other vertically, whereby the vertical movement of the steering column 1 about the tilt pivot 10 can be restricted by causing the primary stopper projection 23' and the secondary stopper projection 24' to be brought into abutment with the lower bracket 19. This brings the same advantage as that provided by the configuration shown in Figs. 1 to 6. Note that while the primary stopper projection 23' and the secondary stopper projection 24' may, as shown in Fig. 16, be provided as part of a mounting member 102 which is fixed to the surface of the gear housing 6 which oppositely faces the lower bracket 19 with bolts, the primary stopper projection 23' and the secondary stopper projection 24' may be projections which are provided direct on the gear housing 6, as shown in Fig. 17.

Another embodiment of the invention, which differs from the embodiment that has been described above, will be described. In Fig. 7, a tilt pivot 10 of this embodiment is such that a lower end portion of a gear housing 6 is brought into direct engagement with a shaft member 26 (refer to Figs. 8(a), (b)) which is mounted on a lower bracket 25 having an inverted U shape cross section which is mounted on the vehicle body. By the configuration like this, when a tilt clamp 9 is in an unclamped state, a steering column 1 can be made to

oscillate about the shaft member 26.

In addition, in this embodiment, a column rotation restricting portion 27 which restrict rotation of the steering column 1 is provided between the lower bracket 5 25 and the gear housing 6.

This column rotation restricting member 27 includes, as shown in Fig. 8(a), a primary stopper projection 28 and a secondary stopper projection 29 which are formed on both sides of the shaft member 26 in such a manner as to oppositely face each other. The primary stopper projection 28 and the secondary stopper projection 29 both project perpendicularly from the gear housing 6, as shown in Fig. 8(b), and distal ends of the projections confront a lower surface  $f$  of the lower bracket 25 with 15 certain gaps held therebetween.

A rotating angle of the tile pivot 10 is such as not only to satisfy a tilt stroke but also to allow for the rotation to a rotating angle equal to or larger than the tilt stroke satisfying angle, and an upper limit and 20 a lower limit are determined for this rotating angle. When the steering column 1 can oscillate from a neutral position downwardly to an angle  $\theta_1$  and upwardly to an angle  $\theta_2$  (refer to Fig. 7), the lower limit and the upper limit of the rotating angle are determined based on angles 25  $\theta_3$ ,  $\theta_4$  as reference which result when certain extra angles

are added to the angles  $\theta_1$ ,  $\theta_2$ , respectively. Consequently, the gap is maintained between the distal end of the primary stopper projection 28 and the lower surface *f* of the lower bracket 25 while the tilt pivot 10 oscillates downwardly until a rotating angle corresponding to the reference angle  $\theta_3$  is reached. On the other hand, the gap between the distal end of the secondary stopper projection 29 and the lower surface *f* of the lower bracket 25 is maintained while the tilt pivot 10 oscillates upwardly until a rotating angle corresponding to the reference angle  $\theta_4$  is reached.

When the tilt pivot 10 reaches rotating angles equal to or larger than the angles corresponding to the reference angles, the gap between the two confronting members is gone, and as this occurs, the steering column 1 oscillating downwards is restrained by virtue of the contact of the primary stopper projection 28 with the lower bracket 25. On the contrary, the steering column 1 oscillating upwards is restrained by virtue of the contact of the secondary stopper projection 29 with the lower bracket 25.

In this embodiment, when the steering column is installed on a vehicle, the steering column 1 attempts to rotate downward about the pin members 20. When the rotating angle increases, since the primary stopper

projection 28 is brought into contact with the lower bracket 25, the steering column 1 cannot rotate further, whereby the downward oscillation is stopped.

Thus, the oscillation of the steering column 1 can be made moderate, whereby, for example, the steering column can be mounted conveniently on a vehicle body without a means such as a screw which resists the rotation of the steering column 1 or a stopper.

In addition, when the steering column 1 is dislodged from the vehicle body mounting portion due to a high load being applied thereto from a steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to spring upwards due to an upward bending moment. When the rotating angle increases, the secondary stopper projection 29 is brought into contact with the lower bracket 25 and the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from springing upwards.

Thus, by making the upward oscillation of the steering column 1 moderate, a free upward movement thereof can be restricted. Consequently, the spring up of the steering column 1 can be prevented by the extremely simple device, i.e., the secondary stopper projection 28, which is added to the existing element, without using a mechanism for preventing the steering column from

springing upwards.

In addition, when the steering column 1 is dislodged from the vehicle body mounting portion due to a high load being applied thereto from the steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to fall downwards. When the rotating angle increases, since the primary stopper projection 28 is brought into contact with the lower bracket 25, the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from falling downwards.

Thus, by making the downward oscillation of the steering column 1 moderate, a free downward movement thereof can be restricted. Consequently, the falling down of the steering column 1 can be prevented by the extremely simple device, i.e., the primary stopper projection 28, which is added to the existing element, without using a mechanism for preventing the steering column from falling downwards.

A further embodiment of the invention, which differs from the embodiments that have been described above, will be described. In Fig. 9, a tilt pivot 10 of this embodiment is disposed coaxially with an axis of a steering column 1 between a gear housing 6 and an inner column of the steering column. The tilt pivot 10 is such



that a yoke member 32 extending from a lower end of the inner column 4 is brought into engagement with two pin members 31 provided on stopper projections (which will be described later on) of a bracket 30 which is mounted on the gear housing 6. By the configuration like this, when a tilt clamp 9 is in an unclamped state, the steering column 1 can be made to oscillate about the pin members 31. In this embodiment, a column rotation restricting portion 33 for restricting oscillation of the steering column 1 is provided between the bracket 30 and the inner column 4. Note that reference numeral 34 in the figure denotes a lower bracket.

This column rotation restricting portion 33 is made up of a pair of stopper projections 35a, 35b which are, as shown in Fig. 10(a), formed below the pin members 31 of the tilt pivot 10 on the bracket 30 in such a manner as not only to oppositely face the yoke member 32 but also to keep a certain gap therebetween and a pair of stopper projections 36a, 36b which are, as shown in Fig. 10(b), formed above the pin members 31 of the tilt pivot 10 on the bracket 30 in such a manner as not only to oppositely face the yoke member 32 but also to keep a certain gap therebetween. These stopper projections 35a, 35a both project from a surface of the bracket 30 in parallel with the axis of the steering column, and distal

ends of the projections confront a front surface  $f$  of the yoke member 32 with a certain gap held therebetween. The stopper projections 36a, 36b also project from the surface of the bracket 30 in parallel with the axis of the steering column, and distal ends of the projections 36a, 36b confront a front surface  $f$  of the yoke member 32 with a certain gap held therebetween.

In this embodiment, an upper limit and a lower limit are determined for a rotating angle of the tilt pivot 10. When the steering column 1 can oscillate from a neutral position downwardly to an angle  $\theta_1$  and upwardly to an angle  $\theta_2$  (refer to Fig. 9), the lower limit and the upper limit of the rotating angle are determined based on angles  $\theta_3$ ,  $\theta_4$  as reference which result when certain extra angles are added to the angles  $\theta_1$ ,  $\theta_2$ , respectively. Consequently, the gaps are maintained between the distal ends of the primary stopper projections 35a, 35b and the front surface  $f$  of the yoke member 32 while the tilt pivot 10 oscillates downwardly until a rotating angle corresponding to the reference angle  $\theta_3$  is reached. On the other hand, the gaps are maintained between the distal ends of the secondary stopper projections 36a, 36b and the front surface  $f$  of the yoke member 32 while the tilt pivot 10 oscillates upwardly until a rotating angle corresponding to the reference angle  $\theta_4$  is reached.

When the tilt pivot 10 reaches rotating angles equal to or larger than the angles corresponding to the reference angles, the gap between the two confronting members are gone, and as this occurs, the steering column 1 oscillating downwards is restrained by virtue of the contact of the primary stopper projections 35a, 35b with the yoke member 32. On the contrary, the steering column 1 oscillating upwards is restrained by virtue of the contact of the secondary stopper projections 36a, 36b with the yoke member 32.

Note that as shown in Figs. 10(a), (b), the bracket 30 is fixed to the gear housing 6 with three bolts 37.

In this embodiment, when installing the steering column on a vehicle, the steering column 1 attempts to rotate downwards about the pin members 20. When the rotating angle increases, since the yoke member 32 is brought into contact with the primary stopper projections 35a, 35b, the steering column 1 cannot rotate further, whereby the downward oscillation thereof is stopped.

Thus, the oscillation of the steering column 1 can be made moderate, and the steering column 1 can be mounted on the vehicle body conveniently without having to use a means such as a stopper which resists the rotation of the steering column 1.

In addition, when the steering column 1 is dislodged

from the vehicle body mounting portion due to a high load being applied thereto from a steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to spring upwards due to an upward bending moment. When the rotating angle increases, since the yoke member 32 is brought into contact with the secondary stopper projections 36a, 36b, the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from springing upwards.

10 In addition, when the steering column 1 is dislodged from the vehicle body mounting portion due to a high load being applied thereto from the steering wheel side, the steering column 1, which is now restrained by only the tilt pivot 10, attempts to fall downwards. When the rotating angle increases, since the yoke member 32 is brought into contact with the primary stopper projections 35a, 35b, the steering column 1 cannot rotate further, whereby the steering column 1 is stopped from falling downwards.

20 Thus, by making the upward or downward oscillation of the steering column 1 moderate, a free upward or downward movement thereof can be restricted. Consequently, the spring up or falling down of the steering column 1 can be prevented by the extremely simple devices, i.e., the secondary stopper projections 36a,

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36b or the primary stopper projections 35a, 35b, which are added to the existing element.

Thus, as has been described heretofore, according to the invention, in the installation of the steering column on to a vehicle, the downward rotation of the steering column can be stopped without using the rotation preventing means such as the screw which is temporarily assembled or a stopper, whereby convenience is enhanced, thereby making it possible to enhance remarkably the assembling efficiency.

In addition, also in the event that the steering column is dislodged from the vehicle body mounting portion when a high load is applied thereto, the spring up or falling of the steering column can be prevented, thereby contributing to an appropriate operation of an occupant protection system or the like.

Thus, while the specific embodiments of the invention have been described in detail, it is obvious to those skilled in the art that various alterations and modifications can be added without departing from the spirit and scope of the invention.

This patent application is such as to be based on the Japanese Patent Application (No. 2003-333840) filed on September 25, 2003, and the contents thereof are incorporated herein by reference.

.<Industrial Application>

The invention can preferably be used as an electric power steering system which is incorporated in a steering system of a vehicle so as to alleviate the steering effort  
5 made by the driver when he or she steers the vehicle by imparting a steering assist force by an electric motor which is fed by a battery.